Task Planning and Scheduling: Toward Real-Time Expert System Autonomous Control

NASA-Lewis Grant NAG3-1088

Final Report
by
Principal Investigator
Leon Sterling, CAISR, CWRU

August 12th, 1991

Research under this grant successfully developed and tested the Interruptable Control System (ICE). The best description of ICE is in the M.S. thesis of Jim Vezina, who was the primary designer and implementer of ICE. Vezina's thesis [2] is included as the bulk of this report.

To test the general usefulness and maintainability of the ICE System, two engineers, George Zwingelstein and Benjamin Leis, extended the examples of the ICE system in action given in Vezina's thesis. The extensions consisted of two components: debugging and rewriting the simulation of passive and active agents, both controlled and uncontrolled, and benchmarking more extensively the HES expert system concerned with monitoring sensors. The expert system can be found in [1] and was chosen because it demonstrates the ability of CLIPS.

1. HES - The sensor monitoring program

The HES program needed some minor changes from the version in [2] and an enhancement to allow it to monitor more sensors. The format of the sensor files was rewritten, creating larger banks of sensors and programs were developed to filter and average the results of multiple runs. Likewise, the equivalent CLIPS program was modified to deal with more sensors and produce an average trial output.

Results were obtained for monitoring 6 and 60 sensors and are summarized in Table 1 below. Numbers in the table correspond to the average number of cycles taken.

	6 sensors	60 sensors	600 sensors
ICE	2143	3595	gave up after 3 days
CLIPS	118281	3688497	gave up

Table 1: Results of HES sensor expert system

2. Active and Passive Agent Simulation

To test the idea of active and passive agents, the well-known monkey and bananas problem from Artificial Intelligence was chosen. The simulation program involved two processes. The first process ran a simulation of a monkey trying to reach a banana by stacking up boxes. The second process directed the monkey and made the decisions. There were four variants on this scenario: an ordinary world, a world where some boxes were faulty and collapsed, a world where some boxes were too heavy to be moved, and finally a world where zombies periodically appeared and frightened away the monkey.

The major problem encountered when running the program was a faulty pipe mechanism for communicating between the processes. Originally, when either an empty pipe was read from or a full pipe was written to, the system would crash. The pipe mechanisms were rewritten using VAX system calls, correcting this problem. There were several other errors that had to be fixed and after several weeks, the first three simulations were running correctly. However, the fourth and most important simulation either ran on forever or crashed after hours of running.

References

[1] Joseph C. Giarranto and Gary Riley, *Expert Systems: Principles amd Programming*, PWS, Kent 1989.

[2] James M. Vezina, ICE System: Interruptible Control Expert System, M.S. Thesis, TR 90-121, CAISR Case Western Reserve University, 1990